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Waterside Environmental Management Incorporating Sustainability and Survivability

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Abstract

This paper aims to demonstrate an adaptive waterside environmental management process that incorporates sustainability, survivability and participation. First, cost-benefit analysis is reviewed critically from the viewpoint of sustainability and survivability. It is suggested that participatory multicriteria analysis is a promising method to aid management decisions from the viewpoint of sustainability and survivability. Then, the new approach is applied in three areas along Kamo River in Kyoto city, two of which are located in the upper river area and one in the downstream area. Based on a social survey of residents, environmental characteristics of each area are determined. The GES environmental valuation function for each area is then defined, and possible priorities for waterside environmental management are presented. Waterside environmental management incorporating sustainability and survivability is thus demonstrated.

Key words: Waterside environmental management, Sustainability, Survivability, Participatory multicriteria analysis, Systems analysis

1. Introduction

In the last decade, and following the publication of Brundtland's report on sustainable development (WCED, 1987), the number of books and papers with the word 'sustainable' in their title has grown enormously. However, the word is used in many different ways (Jordan, 2008). The elasticity of the concept has given rise to questions about what it is supposed to mean: the sustainability of what, for whom, for how long, and why (O'Neill, 2008)? For instance, consider the case of a region which is composed of both urban and rural areas. The rural areas may play important roles including supplying food as well as conserving national land, the head sources of streams and the natural environment. However, the rural areas have lost population, and it has become difficult for the community to fulfill these roles. The remaining rural residents may be in danger of not only losing their way of life, but also their very lives, due to floods and ecological destruction along the river. The urban areas are likely to be affected too. Therefore, as Hagihara and Hagihara (1991) have suggested, the depopulation problem in rural areas must be regarded as a problem for the sustainability of the whole region including both urban and rural areas. Sustainability is not a matter of simply maintaining some aggregate level of human and natural capital. It requires the maintenance of specific resources and goods that meet different human needs and capacities (O'Neill, 2009).

Furthermore, public participation is widely and sometimes rather uncritically embraced as a 'good thing', but more is needed to be known about how best to incorporate it into the management of sustainability (Jordan, 2008), and ultimately, what it actually delivers in terms of residents' and their communities survivability 'on the ground'. By survivability we mean, for individuals, continued life, and for communities their ability to continue to function as a community.

Dam construction in Japan can provide an example of these issues. In the recent conflict over the construction of a weir in Yoshino River, a referendum was carried out in Tokushima city, which is located in the downstream area. As a result the construction of the weir was stopped. However, the people residing mid- and upstream of Yoshino River, who wanted the weir because they are at risk of being flooded, were not included in the referendum, so their views were not reflected in the decision to stop construction. Rather, the result has only reflected the opinion of the people in Tokushima city and other environmentalist groups. Sustainability has been secured in Tokushima city, but both sustainability and survivability of communities and people residing mid- and upstream of Yoshino River were not secured at all.

In this paper, we will argue that, when addressing the issue of sustainability, the questions of *what* is to be sustained, *for whom* sustainability is to be achieved, and *why* sustainability needs to be achieved, must be given careful consideration. First, the implications of a review of cost-benefit analysis are described. This concludes that cost-benefit analysis does not adequately take sustainability and survivability into account. Participatory multicriteria analysis is then discussed. This approach is demonstrated in a regional case study of waterside environmental management using adaptive waterside planning methodology. This case study shows that it is important that the conditions for sustainability and survivability of all areas and population groups be carefully examined.

2. Cost-benefit analysis and sustainability

2.1 Limitations of cost-benefit analysis

Cost-benefit Analysis (CBA) is a common method used to aid decision-making. It has been widely used as an evaluation tool for public policymaking by governments in Japan and around the world.

The main strength of CBA as an appraisal technique is as a test for economic efficiency in resource allocation. The main criticism of CBA is the acceptability of the ethical framework underpinning it. CBA is primarily based on welfare economics. One of the welfare criteria is Pareto Optimality, which requires that no one is made worse off and at least one individual believes he/she is better off after a policy decision. The problem with this is that most policy changes make some people better off and some people worse off simultaneously. So, modern welfare economics is now based upon the Kaldor-Hicks principle of potential compensation, called the potential Pareto principle. That is, if the gainers from a policy gain sufficiently to compensate the losers, the policy is an improvement regardless of whether compensation is actually paid.

In applying the potential Pareto principle, however, it is possible that a policy could actually lower the sum of utilities if people with different levels of wealth have different marginal utilities of money. If the low-wealth person's marginal utility of money is higher than that of the high-wealth person, then it is possible that the utility loss of the low-wealth person could outweigh the utility gain of the high-wealth person. Thus, although the Pareto principle allows us to avoid interpersonal utility comparisons by guaranteeing increases in aggregate utility for policies with positive net benefits, the potential Pareto principle does not do so. The potential compensation criterion is useful in separating efficiency and equity, but has meant that discussions of actual compensation have been avoided on the grounds that equity issues are outside the economists' realm. (see, for example, Hanley and Spash, 1993; Hanley, 2001; Hanley and Barbier, 2009).

2.2 From cost-benefit analysis to participatory multicriteria analysis

According to the economic literature, sustainable development is economic and social development that maintains a certain minimum level of human welfare for present and future generation of humans, in the sense of either maximizing welfare over time or meeting the demands of distributional justice between generations. However, if sustainability is also about equity in distribution over generations, then it raises the same question as to what it is we are supposed to be distributing equally. The question 'Equity of what?' is directly related to the common question among environmental activists and advocates, 'Sustainability of what?' (O'Neill et al, 2008; Munda, 2005,). Much of the environmental valuation literature is concerned with the issue of sustainability; however, they ignore income distribution (see, for example, Hanley and Spash, 1993; Hanley, 2001; Hanley and Barbier, 2009). Yet a sense of fairness is a critical factor in economic decisions (Gowdy, 2004).

Although CBA is adequate to evaluate the efficiency of the policy in question, it does not take into account the equity issues and sustainability aspects of the policy. Therefore, multicriteria analysis (MCA), which includes participatory multicriteria analysis, has been proposed to evaluate policies (Munda, 2005; Kallis, 2006). Sustainability raises a set of issues based on the civil rights of current and future generations as well as respect for ecological systems (Messner, 2006). MCA takes into account a much wider variety of methods than CBA (see, for example, Nijkamp, 1977; Figueira et al, 2005; Getzer et.al, 2005; Vincke, 1992). An essential characteristic of MCA is the consideration of various evaluation criteria, which are weighted in the course of the analysis. In MCA approaches, diverse quantitative, qualitative, and fuzzy criteria can be defined to reflect different kinds of effects as well as trade-offs and synergies. Even CBA results can be included in MCA.

Recently, there has been a push for greater public participation and the inclusion of non-governmental stakeholders in project appraisal. There are different methods for including participation, such as scenario workshops, mediated modeling, and social multicriteria evaluation (Munda, 2005). However, some difficulties have been identified for participatory MCA. Several methodological issues and questions are still subject to debate, such as: What MCA method and which participatory approach should be selected for a particular evaluation problem? Who should determine the criteria? Who decides on the weightings? Who is to be included in the participation process? How can objective results be attained (Messner, 2006)?

With regard to river environmental management in Japan, there have been changes to the legal framework in recent years. Amendments to the first article of the River Law in 1997 expanded the aims of river management to include river environment management and conservation as well as flood control and water use. Further, the 16 th article indicates that river improvement planning systems should be designed to incorporate the opinions of local residents. This is similar to the EU Water Framework Directive in 2000, which requires the ‘active involvement’ of interested parties in developing water resources and environment management plans (Article 14) (Burgess and Clark, 2009; Messner, 2006).

There are challenges in meeting these requirements. For instance, the Yodo River watershed committee provided a report to a director of the Kinki area bureau of the Ministry of Land, Infrastructure and Transport, on methods for incorporating the opinions of local residents. The committee examined past attempts to incorporate the views of local residents and recommended two procedures be used. The first was a procedure which consisted of the provision of written options to local residents together with an explanation at a meeting. The second was a process that consisted of a dialogue with local residents through a series of meetings (the Yodo River watershed committee, 2007). However, they tried both approaches and could not decide which was the best so they are still seeking the best method for incorporating the opinions of local residents.

In the above report, the committee pointed that only small portion of the participants at the meetings had stated their view, so it was difficult to be sure of the strength of various opinions. This indicates that there is a need to develop a more objective approach for collecting local residents' opinions. In the next section, it is shown that one approach is to use a questionnaire survey together with a systems analysis.

3. Waterside environmental management

3.1 Adaptive waterside planning methodology

We have previously proposed an adaptive waterside environmental management process which uses a systems analysis methodology (Hagihara et al, 1998). Systems analysis is a systematic methodology used to solve complicated problems. It is designed to aid decision maker(s) choose the best actions from a range of alternatives. The analysis is done through a series of processes, which include clarifying the decision maker(s)' purpose, evaluating comparative alternatives systematically, and developing new alternatives, if necessary. The adaptive waterside environmental management process we proposed consists of the following processes: (i) problem identification; (ii) field research; (iii) analysis to clarify the key issues; (iv) modeling alternatives; (v) evaluation which includes, for example, CBA, MCA and Social Impact Assessment; and (vi) conflict management if there are conflicts among stakeholders. This process provides a methodology for decision aiding, not decision making. If insufficient evaluation results are obtained and/or there is no possibility of compromise, we would return to the process of modeling alternatives and problem identification. Thus a particular feature of the systems analysis here is that the whole process is in fact a nested (Hagihara, 2008). In this adaptive waterside environmental management methodology, each process requires information, for example, the physical features of the waterside environment; and what residents are concerned about and want. As a result, public participation for decision aiding is realized in each process by taking advantage of a common set of information. This information, derived from a survey of residents, using a well designed questionnaire, can provide a lot of the information, and thus can meet the requirements for public participation. Participation by residents with diverse opinions is secured by statistical sampling.

3.2 Case study research areas

Kamo River flows through Kyoto city. Three areas were selected for study by applying a principal component analysis based on demographic/physical data to all the areas of Kyoto city. Suemaru is located downstream, in downtown Kyoto city, while Ohara and Kumogahata are located in the upper river area. Ohara is a famous historical sightseeing area, while Kumogahata is located in the mountains and has no significant sightseeing features.

Demographically the areas are very distinct. In 2005 the populations were 1,475,000 in Kyoto city, 2792 in Dohda where Suemaru is included, 2526 in Ohara and 218 in Kumogahata. Since 1985, the population of Kyoto city has changed little and has even increased recently, but the population of two areas in the upper river area has decreased, particularly in Kumogahata where it declined by 30.1% between 1985 and 2005. According to the Special Measures for the Development of Depopulated Areas, Kumogahata has satisfied one of the necessary conditions for the depopulated areas with regard to decline in population. However, Kumogahata is a part of Kyoto city and the city is not designated as a depopulated area. With respect to the structure of the population, the population under 15 has decreased in Kyoto city as a whole, particularly in Ohara (by 14.1%), while the population over 65 has significantly increased in Ohara and Kumogahata, by 23.6% and 18.2%, respectively.

3.3 The social survey

The environment in this study is defined as being composed of three layers: the Geo-environment where the law of geophysics governs, the Eco-environment where the law of ecology governs, and the Socio-environment where rules of society govern, (Hagihara et al 1998). If the geological space where the Geo-environment exists is the entire earth, the Eco-environment cannot exist without the Geo-environment and the Socio-environment without the Geo-and Eco-environments. Humans are members of the Geo-, Eco- and Socio-environments.

The features of physical Geo-, Eco- and Socio environment in case study areas have been already reported (Hagihara et al., 2009). First, as for Geo-environment, a meteorological and hydrological condition, i.e., annual precipitation, river flow rate, water quality and ground water level were researched. Seismic, flood and landslide risks were also investigated. Second, as for Eco-environment, vegetation of the Kamo River basin and distribution of animals in the area were surveyed. Then, with regard to Socio-environment, first, water utilization networks of water supply, sewage pipes, and rain water drain pipes were investigated. Second, network of roads were also investigated.

Preliminary field research was undertaken in each area consisting of interviews of a range of residents about not only the waterside environment, but also their living circumstances. For example, with regard to their living circumstances, residents of Kumogahata, were very concerned about the sustainability of their living conditions. In particular they complained about poor medical services, inconvenient shopping, and the very poor bus services to the center of the city where a hospital and a shopping center are located. They were even worried about whether the area will continue to exist in the future.

Following this, to quantify residents' concerns and wishes for the waterside environment, a survey was conducted of residents of the three areas. The questionnaire was composed of the following types of questions: 'How are you aware of the waterside?', 'What is your impression of it?', and 'What actions do you want to see concerning it?'. Each questionnaire took into account the differences of the Geo-, Eco-, and Socio-environment in the three areas with the aid of the earlier field surveys, interviews with residents, the KJ method and the ISM (Interpretive Structuring Modeling) method. Specifically, the questionnaire is divided into sections relating to the Geo-, Eco-, and Socio-environment. The questionnaire also included common items in order to compare results among areas (See Hagihara et al., 2009).

We conducted a mail survey of all households in Suemaru in 2006 and in the historical sightseeing communities of Ohara and Kumogahata in 2007. The percentage of respondents (number of respondents) were 44%(61), 28%(61), and 63%(45), respectively.

4. Results of a social survey

4.1 Results of simple aggregation

The majority of residents in all areas responded that they are happy to live along the river. In Suemaru in the downstream area, residents responded that the 'river terrace is sufficiently wide', they 'enjoy the spring season (cherry blossoms)', and they are 'happy to see Daimonji-Okuribi (which is a famous religious event on the mountain over the river)', and so on. They enjoy playing at the waterside of the Kamo River and seeing cherry blossoms.

On the other hand, in both upper river areas, more than 70% of residents responded that 'industrial waste disposal facility is a nuisance to them', 'wild monkeys are a nuisance', 'insufficient forest is preserved', and 'flood protection is insufficient'. In addition to these responses, in Ohara, residents also indicated that 'they are anxious about the aging of the area's population and its declining birth rate' and that 'measures for domestic wastewater are necessary'. Further, a significant proportion of these residents responded that 'water quality is not good' and that 'open space along the river is necessary'. Residents in Kumogahata indicated that 'they feel at risk of landslide and flood' and that 'wild boars, deer, bears and bees are a nuisance', 'water quality is good' and 'open space along the river is not necessary'.

Different responses were thus obtained in the upper and down river areas, and even in the same upper river area. Given this, there is a need to take these differences into account in the waterside environmental management of the Kamo River.

4.2 GES environment in each area

In order to systematically analyze the differences between the study areas, a GES environmental structure of the residents' concerns was developed for each study area. They are depicted in Figures 1–3.

The procedure for creating the structures in Figures 1–3 was as follows: (i) Questionnaire items were divided into groups based on the results of the social survey; (ii) the re-

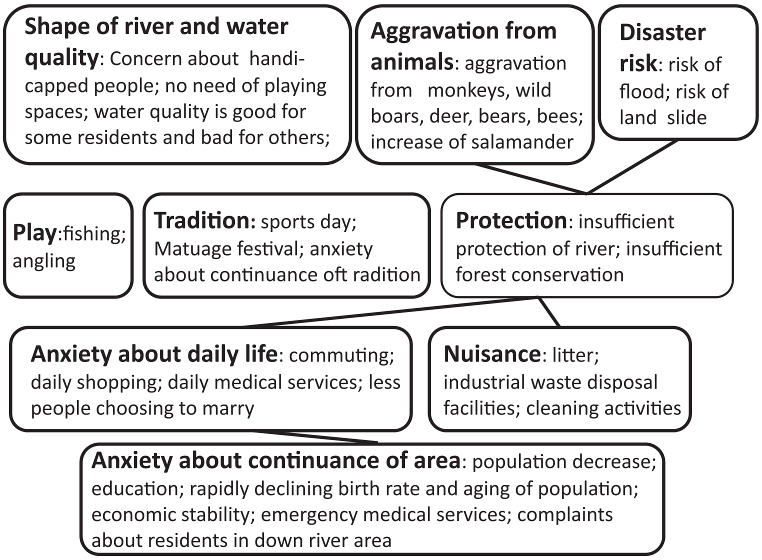

Figure 1　GES environmental structure of residents' concerns in the upper river area of Kumogahata

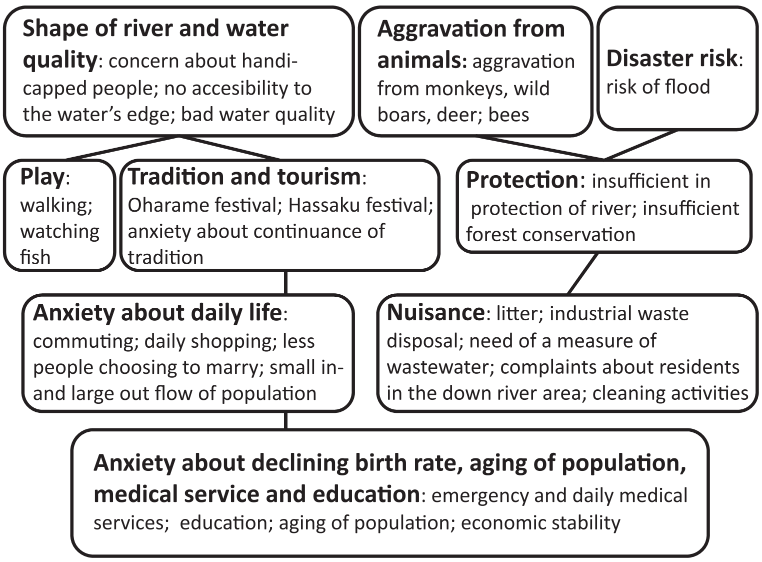

Figure 2　GES environmental structure of residential concerns in the upper river areas of Ohara

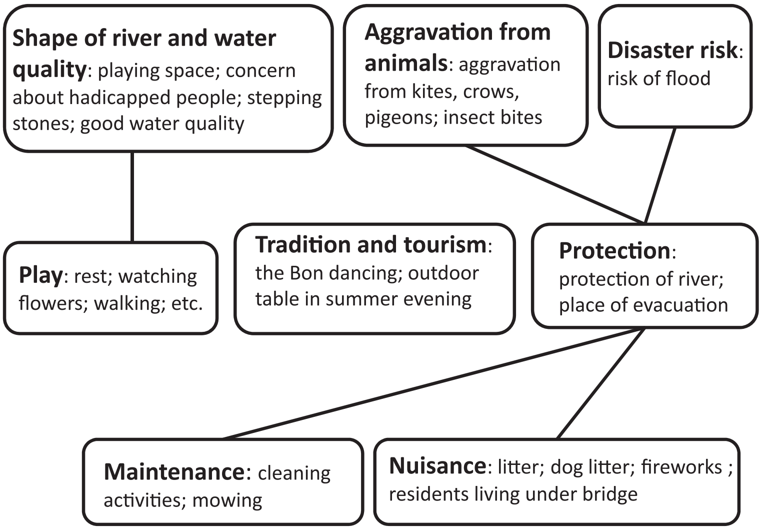

Figure 3　GES environmental structure of residential concerns in the down river area of Suemaru

lationship between groups was determined with the aid of Cramer's Coefficient of Relationship (Cramer, 1946) and lines were drawn between groups if their relationship was assessed as strong.

Cramer's coefficient of relationship which use χ^2-value and analyzes the relationship between two items is applied in this study. Cramer's coefficient of relationship, ϕ, is described as below.

$$\phi = [\chi^2/\{N(k-1)\}]^{1/2}$$

, where χ^2 is χ^2–value, N is sample number, k is the number of less category, or option in two items. The range of the value ϕ is between 0 and 1.0. With regard to the intensity of relationship, if $\phi \geq 0.3$, it is interpreted as strong relationship between two items.

In the figures, the names of the groups are written in bold characters. Based on these structures, there are a number of observations:

(1) Difference of concerns between areas: Although the concerns are labeled with the same group names, what they refer to differs between areas. For example, 'disaster risk' appears in all figures, but in Kumogahata 'risk of landslide' is a concern in addition to 'risk of flood'.

Moreover, 'shape of river and water quality' appears in all figures and what it refers to is almost the same for each area, but it is viewed quite differently: with open space being sufficient in the down river area, while it is not sufficient in Ohara and it is not necessary in Kumogahata. Regarding 'loss of animals', the type of animal referred to differs; that is, the loss of kites and other birds are a concern in the down river area, while residents of the upper river areas are concerned about the welfare of mammals, such as deer. Further, the loss of the Japanese giant salamander, which is the world's largest amphibian and a national protected animal in Japan, is a concern in Kumogahata, but not in other areas.

In Kumogahata in particular, residents were anxious about daily life (i.e., commuting, medical services, and fewer people choosing to marry) as well as the continuance of the area (i.e., population decrease, economic stability, emergency medical services, and so on). On the other hand, residents in Ohara were not anxious about the continuance of the area in spite of being in the same upper river area. Residents in Suemaru were not anxious about the above issues at all.

(2) Difference among groups which have a strong relationship with 'shape of river and water quality': The strong connection between 'play' and 'shape of river and water quality' implies that a substantial plan incorporating "play" is needed in the down river area. In Ohara there are strong concerns with 'tradition and sightseeing', because a lot of residents earn their living through tourism. Thus, in addition to improving the open space for playing and walking at the waterside, there is a need to take tourism into account in Ohara. On the other hand in Kumogahata residents think that there is no need to improve the waterside. What improvement at the waterside entails differs between areas, implying that these differences would need to be considered in waterside management.

(3) The relationship between items in the Geo- and Eco-environment and the Socio-environment: it is noted that groups of 'disaster risk (Geo-)' and 'loss caused by animals (Eco-)' are connected to 'nuisance (Socio-)' and 'anxiety about daily life (Socio-)'. This implies that measures for dealing with disasters should include, as well as physical ones, measures for reducing nuisance activity, cleaning activity, and other items of the Socio-environment. Consequently, 'protection of river' should be considered from the viewpoint of the Socio-environment, as well as that of the Geo- and Eco-environment. For example, in the case of dam construction (very common in regional development initiatives in Japan), not only should the effectiveness of flood control in the down river area be a consideration, but also the improvement or maintenance of the quality of daily life in the upper river areas should be adopted as criteria in weighing up alternative proposals.

5. Evaluation of each waterside environment

To more precisely calibrate residents' perceptions of their waterside environment, a GES environmental valuation function is created for each area. We will be able to clarify "what" elements of GES environment and "how" they are evaluated by people with the aid of the GES environmental valuation function.

5.1 Creating valuation functions

The development of a GES environmental valuation function for each area was undertaken as follows: Numbers of questionnaire items are approximately more than 30. First, we are trying to get useful information on the GES environment in each area from these many questionnaire items. Twelve representative variables were selected for explaining the GES environment in each area based on a following criteria, that is, they include items which are elements of each Geo-, Eco- and Socio-environment, and items to which many people respond (see the second column of Tables 3–5; Hagihara et al, 2009). Then, using these items, valuation axes were obtained with the aid of the Hayashi's Quantification Theory III (Yasuda and Unno, 1977).

Finally, the GES environmental valuation function in each area is derived.

Three valuation axes were obtained in each area from the results of the Hayashi's Quantification Theory III (Hagihara et al., 2009). Numbers of valuation axes are decided by a criterion, that is, axes' cumulative contribution ratio is more than 50%. This value, 50%, is derived from the idea that we should use information as much as possible, but it is difficult, so we should use at least a half of the information which is given by people. The interpretations of these axes are shown in Table 1. In the upper river area there are axes which indicate concern about pleasure at the waterside and difficulties in daily life, while in the down river area there are axes which indicate anxiety about the waterside as a user and anxiety about flooding. In Table 1, the values in parenthesis are the cumulative contribution ratio and the values in each box are the contribution ratio of each axis.

Table 1　An Interpretation of Axes

	Suemaru (53.3%)	Ohara (51.6%)	Kumogahata (50.2%)
1st axis	Anxiety about the waterside as a user 24.8%	Pleasure at the waterside: 21.3%	Difficulties in daily life: 20.2%
2nd axis	Anxiety about flood 16.1%	Difficulties in daily life: 18.9%	Pleasure at the waterside: 17.5%
3rd axis	Feeling of the season 12.4%	Complaint about residents in down river areas: 11.4%	Complaint about the area: 12.6%

A GES environmental valuation function is defined with sample scores and weights as follows:

$$D_i = \sum_r w_r \sum_j \frac{\delta_i(j) x_{rj}}{l_i}$$

$$\text{where } \delta_i(j) = \begin{cases} 1 & \text{if sample } i \text{ responds to item } j, \\ 0 & \text{otherwise} \end{cases}$$

w_r is weight at each axis, l_i is the number of items which sample i responds to 12 items, x_{rj} is category scores of j items at axis r.

Although it is not easy to decide weights in multicriteria analysis, contributing ratio on each axis is used as the weight in this paper. Thus, the GES environmental valuation function for each area is as follows:

In Suemaru:

$$D_{si} = -\frac{24.8}{l_i}\sum_{j=1}^{12}\delta_i(j)x_{1j} - \frac{16.1}{l_i}\sum_{j=1}^{12}\delta_i(j)x_{2j} - \frac{12.4}{l_i}12\sum_{j=1}^{12}\delta_i)(j)x_{3j}$$

In Ohara:

$$D_{oi} = \frac{21.3}{l_i}\sum_{j=1}^{12}\delta_i(j)x_{1j} - \frac{18.9}{l_i}\sum_{j=1}^{12}\delta_i(j)x_{2j} - \frac{11.4}{l_i}\sum_{j=1}^{12}\delta_i(j)x_{3j}$$

In Kumogahata:

$$D_{ki} = -\frac{20.2}{l_i}\sum_{j=1}^{12}\delta_i(j)x_{1j} + \frac{17.5}{l_i}\sum_{j=1}^{12}\delta_i(j)x_{2j} - \frac{12.6}{l_i}\sum_{j=1}^{12}\delta_i(j)x_{3j},$$

where subscripts s, o and k represent Suemaru, Ohara and Kumogahata, respectively.

These GES environmental valuation functions enable us to see how each item affects the sample i, i.e., people's GES environmental value and in what manner and by how much.

Further, the effect of item j on the GES environmental value in each area, x_j ($j=1, \ldots, 12$), is defined as follows

$$x_j = \sum_r w_r x_{rj},$$

where x_{rj} is category scores of j items at axis r and w_r is the contributing ratio on each axis.

The value of x_j is the magnitude and the direction of effect by item j on the GES environmental valuation function. For example, if x_j is positive, the GES environmental value increases, and if it is negative, the GES environmental value decreases. The score in each area is shown as follows:

In Suemaru,

$$x_{sj} = -24.8\, x_{1j} - 16.1\, x_{2j} - 12.4\, x_{3j}$$

In Ohara,

$$x_{oj} = 21.3\, x_{1j} - 18.9\, x_{2j} - 11.4\, x_{3j}$$

In Kumogahata,

$$x_{kj} = -20.2\,x_{1j} + 17.5\,x_{2j} - 12.6\,x_{3j}$$

5.2 Identifying priorities for action

Based on the above equations, alternative actions can now be proposed for waterside management in each location.

(1) Suemaru: Scores for Suemaru are shown in Table 2. From the total scores, the items ‘rest’, ‘knowledge about the loss of kites’, and ‘recognize risk of flood’ decrease GES environmental value in Suemaru. On the other hand, the items ‘enjoy watching fireflies’ and ‘appreciate lack of grass’ increase the GES environmental value. Consequently, important elements of waterside management should include actions that decrease the fear of the loss of kites and the risk of flood; conserve the ecological environment which will bring about the enjoyment of watching fireflies and the enjoyment of the season; as well as regular mowing and improving the area for walking.

(2) Ohara: Scores for Ohara are shown in Table 3. The items ‘daily shopping is inconvenient’, ‘daily medical service is inconvenient’, ‘water quality is bad’, and ‘illegal disposal of waste is annoying’ decrease GES environmental value in Ohara. On the other hand, the items ‘easy accessibility to the water edge’ and ‘enjoy the (traditional) Hassaku dance’ increase the GES environmental value significantly. Consequently, introducing measures to improve drainage facilities for wastewater, thus increasing the water quality, as well as measures to improve accessibility to the water’s edge and to create substantial playing spaces should be a priority. Further, daily life should be improved to the minimum necessary for residents to continue to live in the community, and for the community to con-

Table 2　Scores of Suemaru

j	items	Anxiety and complaint in daily use	Anxiety about flood	Feeling of the season	Total scores
1	river terrace is adequate	0.918	−0.187	0.086	0.818
2	Recognize risk of flood	−0.465	−2.556	0.443	−2.578
3	Fond of cherry blossoms	0.559	0.393	−0.166	0.786
4	Extinguish introduced species	1.046	−0.063	−0.263	0.719
5	Knowledge about loss by kite	−2.553	−0.355	−0.321	−3.23
6	Rest	−2.114	0.405	−1.646	−3.355
7	Watching flowers	−1.746	0.244	1.034	−0.467
8	Dog litter	−0.981	0.76	0.67	0.448
9	Enjoy watching fireflies	−0.084	0.929	0.706	1.551
10	Enjoy Okuribi	0.351	−0.178	−0.137	0.036
11	Participate in cleaning activities	0.430	−0.065	−0.043	0.322
12	Appreciate lack of grass	1.163	0.158	−0.294	1.027

Table 3　Scores of Ohara

j	items	Anxiety and complaint in daily use	Anxiety about flood	Feeling of the season	Total scores
1	river terrace is adequate	0.918	−0.187	0.086	0.818
2	Recognize risk of flood	−0.465	−2.556	0.443	−2.578
3	Fond of cherry blossoms	0.559	0.393	−0.166	0.786
4	Extinguish introduced species	1.046	−0.063	−0.263	0.719
5	Knowledge about loss by kite	−2.553	−0.355	−0.321	−3.23
6	Rest	−2.114	0.405	−1.646	−3.355
7	Watching flowers	−1.746	0.244	1.034	−0.467
8	Dog litter	−0.981	0.76	0.67	0.448
9	Enjoy watching fireflies	−0.084	0.929	0.706	1.551
10	Enjoy Okuribi	0.351	−0.178	−0.137	0.036
11	Participate in cleaning activities	0.430	−0.065	−0.043	0.322
12	Appreciate lack of grass	1.163	0.158	−0.294	1.027

Table 4　Scores of Kumogahata

j	items	Difficulties in daily life	Pleasure at the waterside	Complaint about the area	Total scores
1	Water quality is good	0.517	1.548	−0.718	1.347
2	Easy access to the water's edge	1.351	2.142	0.102	3.594
3	Recognition of flood risk	0.639	−0.217	0.358	0.781
4	Increase the amount of the area of coppice	0.396	−1.139	−2.253	−2.995
5	Fond of rhododendron	0.683	−1.498	0.090	−0.725
6	Fond of Japanese sculpin	1.052	−0.903	0.406	0.555
7	Deer are annoying	0.749	0.328	0.561	1.637
8	Enjoy Matuage festival	−0.067	0.073	0.432	0.438
9	Aging of population	−1.083	0.413	−0.781	−1.452
10	Daily medical services	−2.466	−0.078	0.479	−2.065
11	Daily shopping	−1.724	−0.862	0.372	−2.214
12	Emergency medical services	−2.073	0.933	0.025	−1.115

tinue to function.

(3) Kumogahata: Scores for Kumogahata are shown in Table 4. The items 'it is good to increase the amount of wooded areas', 'daily shopping is inconvenient' and 'daily medical service is inconvenient' decrease the GES environmental value in Kumogahata signficantly. According to the interviews with residents, people who think that it is good to increase the amount of wooded areas also desire other changes in the area, in particular a transition from the timber industry to an alternative industry. On the other hand, the items 'it is easy to go the water's edge' and 'water quality is good' increase the GES envi-

ronmental value in Kumogahata. Consequently, the improvement of the quality of daily life is the top priority, noting that it is not an easy task for governments to make changes to improve some aspects daily life.

6. Concluding remarks

The ambiguity in the definition of sustainability has led to many different interpretations. In this paper we first showed that the concept of "sustainability" should include both sustainability and survivability. We then explored an adaptive waterside environmental management process, which includes public participation, in case studies in the upper and down river areas of the Kamo River in Kyoto city in Japan.

In the adaptive waterside environmental management process, it has been shown that both upper and down river areas are able to be considered from the viewpoint of not only sustainability but also survivability. In particular, it has been shown that it is necessary to take into account differences among residents both in rural and urban areas in a region. Furthermore, the kind of measures which are needed to improve the riverside problems of each area can be identified through the use of an environmental valuation function based on a survey of residents. Thus it is shown the waterside environmental management process presented in this paper can take into account both sustainability and survivability for different areas and populations in a region.

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